

## **REMARKS/ARGUMENTS**

This Amendment is responsive to the Office action dated July 5, 2005, setting forth a shortened three month statutory period for reply expiring on October 5, 2005. This Amendment is submitted with a petition for a one month extension of time to reply, making the Amendment due on or before November 5, 2005.

Claims 1-58 were pending in the application, with claims 1, 38, and 53 being independent claims. By this Amendment, claims 1, 10, 18, 26, 27, 29, 38, 49, and 51 have been amended, claims 37, 40, and 52-58 have been canceled without prejudice, and claims 59-60 have been added.

Accordingly, the claims now pending in the application are claims 1-36, 38-39, 41-51, and 59-60, with claims 1, 38, and 59 being independent claims.

### **I. Objection to Claim 1**

Claim 1 is objected to for using the word "than" twice. Claim 1 is amended herein to delete the second instance of "than." Claim 18 is also reworded herein to correct the same issue.

### **II. Response to Claim Rejections under 35 U.S.C. § 112**

In the Office action, claims 1-36 are rejected under 35 U.S.C. § 112, ¶ 2 as being indefinite because claim 1 fails to establish whether the limitation "contains atoms of at least one of carbon and silicon . . . to stop the oxidation of the dielectric" applies to the copper or the oxidizing agent. As originally set forth, it is believed that the subject limitation clearly applied to the precursor. Nonetheless, for purposes of furthering prosecution and without narrowing the scope of the claim, claim 1 is amended herein to provide: "the precursor contains atoms of at least one of carbon and silicon in amount sufficient to stop oxidation of the dielectric."

Claim 1, as amended, is now believed to be in proper form under 35 U.S.C. § 112, ¶ 2, and such indication is requested. Further, the dependent claims 2-36 are also believed to be in proper form under 35 U.S.C. § 112, ¶ 2, and such indication is requested.

Dependent claims 4 and 5, which depend from claim 1, are also rejected under 35 U.S.C. § 112, ¶ 2 as being indefinite. With respect to each of these claims, the Examiner

asserts that it is unclear how an oxidizing agent of oxygen or nitrogen can contain atoms of carbon and silicon. As clarified above, claim 1 teaches that the precursor, not the oxidizing agent, contains atoms of at least one of carbon and silicon. Claim 1 also teaches that the precursor contains an oxidizing agent. Dependent claim 4 teaches a precursor containing an oxidizing agent of oxygen. Dependent claim 5 teaches a precursor containing an oxidizing agent of nitrogen. In sum, the precursor contains atoms of at least one of carbon and silicon as taught by claim 1, as well as an oxidizing agent, such oxidizing agent being oxygen in claim 4 and nitrogen in claim 5. Thus it is not oxygen or nitrogen, but the precursor that is taught to contain atoms of at least one of carbon and silicon. With this clarification in mind, it is believed that claims 4 and 5 are in proper form under 35 U.S.C. § 112, ¶ 2, and such indication is requested.

### **III. Response to Claim Rejections Under 35 U.S.C. § 103(a)**

#### **A. Claims 1-4 and 6-29 are not obvious in view of the combination of Crawford and Phaneuf**

In section 17 of the OA, claims 1-4 and 6-29 are rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent No. 6,653,240 to Crawford (hereafter "Crawford") in view of U.S. Patent No. 6,641,705 to Phaneuf et al. (hereafter "Phaneuf"). Referring to independent claim 1, it is alleged that Crawford teaches all elements of this claim, except for a "precursor [that] . . . has a sticking coefficient greater than about 0.01 and a residence time longer than about 100 ns on the copper" as found in claim 1. To account for the deficient teaching of Crawford, it is alleged that Phaneuf renders the above-recited limitations obvious.

A prima facie case of obviousness under 35 U.S.C. § 103 requires that the prior art references teach or suggest all the claim limitations. Neither Crawford nor Phaneuf teaches or suggests the requirement found in claim 1 that the precursor contain atoms of at least one of carbon and silicon in an amount sufficient to stop oxidation of the dielectric. Thus, the combination of Crawford and Phaneuf does not teach or suggest all of the limitations of the independent claims.

In addition, neither of these references teaches nor suggests the requirements found in claim 1 for the sticking coefficient and residence time of the oxidizing precursor. It is asserted, however, that although Phaneuf does not explicitly teach that the oxidizing precursor should exhibit the claimed sticking coefficient and residence time, it would have been obvious to one of

ordinary skill in the art to seek an oxidizing precursor with the claimed characteristics because the chemical composition and purpose of the oxidizing precursor in the invention of Phaneuf is the same as its chemical composition and purpose in the claimed invention.

While the Examiner correctly observes that the invention of Phaneuf and the claimed invention both teach the use of an oxidizing agent, the purpose of the oxidizing agent differs. Phaneuf teaches an oxidizing agent such as water or oxygen gas to selectively inhibit etching of the dielectric and to prevent re-deposition of sputtered material. See Phaneuf, col.14, lines 20-23, 37-43. By contrast, one theory of operation of the invention of claim 1 contemplates an oxidizing agent to reorganize surface copper atoms and thereby improve etching uniformity. Further, the chemical composition of the oxidizing agent taught by Phaneuf differs from that of the oxidizing precursor taught by the instant claims. The invention of claim 1 teaches an oxidizing precursor that "contains atoms of at least one of carbon and silicon in amount sufficient to stop oxidation of the dielectric," a formulation that Phaneuf fails to teach. Because the chemical composition and function of the oxidizing agent differs between the two inventions, it would not be obvious to one of ordinary skill that the requirements for residence time and sticking coefficient of the oxidizing agent in each invention should be the same.

A second requirement for a prima facie case of obviousness under 35 U.S.C. § 103 is that there be some suggestion or motivation, either in the prior art references or in the knowledge generally available to one of ordinary skill in the art, to combine reference teachings. With respect to independent claim 1, there is no suggestion or motivation to combine the teachings of Crawford with those of Phaneuf. On the contrary, the oxygen-containing gas taught by Phaneuf to selectively inhibit etching of a traditional dielectric would lead to enhanced etching and reactive degradation of the organic dielectric taught by Crawford, a result that would discourage rather than motivate combination of the two references. However, when the oxygen-containing gas also "contains atoms of at least one of carbon and silicon in amount sufficient to stop oxidation of the dielectric," as taught in claim 1, reactive degradation of the organic dielectric can be prevented.

For the foregoing reasons, independent claim 1 is patentable under 35 U.S.C. § 103 over the combination of Crawford and Phaneuf. Claims 2-4 and 6-29 depend from claim 1 and therefore include the same limitations as the underlying independent claims. Thus, the dependent claims are patentable over the combination of Crawford and Phaneuf for at least the

same reasons as the independent claim. The Applicant makes this statement without reference to or waiving the independent bases of patentability within each dependent claim.

**B. Claim 5 is not obvious in view of the combination of Crawford and Kuckertz et al.**

In section 18 of the OA, claim 5 is rejected under 35 U.S.C. § 103(a) as unpatentable over Crawford in view of U.S. Patent No. 6,613,394 to Kuckertz et al. (hereafter "Kuckertz"). Claim 5 depends from claim 1, and therefore includes the same limitations as the underlying independent claim. As the Examiner noted in section 17 of the OA, Crawford is deficient with respect to several teachings of the claimed invention, limitations which Kuckertz also fails to teach. Thus, the dependent claim is patentable over the combination of Crawford and Kuckertz for at least the same reasons as the independent claim is patentable over Crawford alone. The Applicant makes this statement without reference to or waiving the independent bases of patentability within each dependent claim. For at least the foregoing reasons, claim 5 is patentable under 35 U.S.C. § 103 over the cited references. As such, the Applicant respectfully requests that the claim be allowed.

**C. Claims 1-2, 30, 34-36, 38 and 40-51 are not obvious in view of the combination of Crawford and Fischer**

In section 19 of the OA, claims 1-2, 30, 34-36, 38, and 40-51 are rejected under 35 U.S.C. § 103(a) as unpatentable over Crawford in view of U.S. Patent Application Publication 2004/0132287 to Fischer et al. (hereafter "Fischer"). Referring to independent claim 1, it is alleged that Crawford teaches all elements of this claim, except for a "precursor [that] contain[s] a compound based on siloxane." To account for the deficient teaching of Crawford, it is alleged that Fischer renders the above-recited limitations obvious.

As an initial matter, it should be noted that independent claim 1 does not teach the use of a precursor containing a compound based on siloxane. Therefore Fischer, a prior art reference cited by the Examiner for its teaching of a precursor containing such a compound, will not remedy the deficiencies of Crawford with respect to claim 1. Further, as discussed above, a prima facie case of obviousness under 35 U.S.C. § 103 requires that the prior art references teach or suggest all the claim limitations. Neither Crawford nor Fischer teaches or suggests the limitation found in claim 1 that the precursor contain atoms of at least one of carbon and silicon sufficient to stop oxidation of the dielectric. In addition, neither reference teaches or suggests

the requirements found in claim 1 for the sticking coefficient and residence time of the oxidizing precursor. Thus, the combination of Crawford and Fischer does not teach or suggest all of the limitations of independent claim 1. For at least this reason, independent claim 1 is patentable under 35 U.S.C. § 103 over the combination of Crawford and Fischer. Claims 2, 30, and 34-36 depend from claim 1 and therefore include the same limitations as the underlying independent claim. Thus, the dependent claims are patentable over the combination of Crawford and Fischer for at least the same reasons as the independent claim. The Applicant makes this statement without reference to or waiving the independent bases of patentability within each dependent claim.

Referring to independent claim 38, it is alleged that Crawford teaches all elements of this claim except for a "precursor [that] contain[s] a compound based on siloxane." Claim 38 has been amended to remove the language referring to "a compound based on siloxane." With respect to the amended version of claim 38, neither Crawford nor Fischer teaches or suggests a precursor containing at least one member of the group consisting of NitroEthanol, NitroEthane, NitroPropane, NitroMethane, and compounds based on silazane. Thus, a prima facie case of obviousness under 35 U.S.C. § 103, which requires that the prior art references teach or suggest all of the claim limitations, has not been made out. For this reason, independent claim 38 is patentable under 35 U.S.C. §103 over the combination of Crawford and Fischer. Claims 40-51 depend from claim 38 and therefore include the same limitations as the underlying independent claim. Thus, the dependent claims are patentable over the combination of Crawford and Fischer for at least the same reasons as the independent claim. The Applicant makes this statement without reference to or waiving the independent bases of patentability within each dependent claim.

#### **IV. New Claims**

Independent claim 59 and dependent claim 60 have been added in this amendment. Independent claim 59 teaches an oxidizing precursor comprising "compounds based on siloxane." This limitation was previously contained in independent claim 38, which is amended in this version. Independent claim 38 in its previous form is rejected in section 19 of the OA as unpatentable over Crawford in view of Fischer. Referring to independent claim 38 in its previous form, it is alleged that Crawford teaches all elements of this claim, except for a

"precursor [that] contain[s] a compound based on siloxane." To account for the deficient teaching of Crawford, it is alleged that Fischer renders the above-recited limitations obvious.

With reference now to claim 59, a *prima facie* case of obviousness based on a combination of prior art references requires that there be some suggestion or motivation, either in the prior art references or in the knowledge generally available to one of ordinary skill in the art, to combine reference teachings. The motivation or suggestion to combine prior art references must be present at the time the claimed invention was made. See MPEP § 2141.01 ¶ III. With respect to independent claim 59, which now contains the limitation rejected by the Examiner, the Applicant asserts that no such suggestion or motivation to combine existed at the time the claimed invention was made.

The accepted wisdom in the prior art held that "beam assisted reactions between organic low-k dielectric material and oxygen containing precursor molecules lead[s] to deterioration of the dielectric structure." See Makarov et al., U.S. Patent Publication Number 2005/0072756, ¶ 21 (the publication of the present application). Therefore, at the time the claimed invention was made, there would have been no motivation or suggestion to combine Crawford, a reference teaching FIB milling of copper adjacent to an organic dielectric, with Fischer, a reference teaching the use of TMCTS, an oxygen-containing gas precursor. Motivation or suggestion to combine would be apparent only in hindsight, an impermissible consideration in a rejection under 35 U.S.C. § 103(a). See MPEP § 2141.01 ¶ III. Because, absent impermissible hindsight, there was no motivation to combine Crawford with Fischer at the time the claimed invention was made, the Examiner has not made out a *prima facie* case of obviousness. Thus, the Applicant urges that independent claim 59 is allowable.

Assuming *arguendo* that a *prima facie* case of obviousness with respect to independent claim 59 has been made out, it may be rebutted by evidence of unexpected advantageous properties resulting from the limitations taught by the claim. See MPEP § 716.02(a) ¶ II. Here, the use of a precursor comprising a compound based on siloxane, as taught by independent claim 59, resulted in an unexpected decrease in the deterioration of the organic dielectric. Such a decrease is an advantageous property within the meaning of MPEP § 716.02(a) ¶ II.

As discussed above, at the time the claimed invention was made, the prior art revealed that oxygen-containing gas precursors tended to degrade organic dielectrics. One would expect, then, that a precursor comprising a compound based on siloxane, which contains

oxygen, would tend to degrade organic dielectrics in a similar fashion. However, as taught by the present application, the use of such a precursor in fact results in decreased deterioration of the organic dielectric relative to the deterioration observed where other oxygen-containing gas precursors, like water or oxygen gas, are used. Thus, the advantageous property of reduced deterioration of the organic dielectric, observed where the precursor comprises a compound based on siloxane, was unexpected. Under MPEP § 716.02(a) ¶ II, this evidence of an unexpected advantageous property rebuts prima facie obviousness with respect to independent claim 59.

Thus, for at least the reasons set forth above, it is believed that new claim 59 is patentable over the combination of Crawford and Fischer et al., and such indication is respectfully requested. Claim 60 depends from claim 59 and therefore includes the same limitations as the underlying independent claim. Thus, dependent claim 60 is patentable over the combination of Crawford and Fischer et al. for at least the same reasons as independent claim 59. The Applicant makes this statement without reference to or waiving the independent bases of patentability within each dependent claim.

#### **V. Allowable Subject Matter**

Applicant thanks the Examiner for the indication that claims 31-33 and 39 would be allowable if rewritten in independent form. At this time, claims 31-33 and 39 are not amended as it is believed that the base claims are patentable over the cited references at least for the reasons set forth herein. Applicant reserves the right to amend the claims at a later date.

#### **VI. Claims 26, 27, 29, 49, and 51**

Claims 26, 27, 29, 49, and 51 are amended to correct the spelling of the word "Celsius."

### **CONCLUSION**

In view of the above, claims 1-36, 38-39, 41-51, and 59-60 remain in the application and all are in form for allowance for at least the reasons set forth herein. The application is believed to be in condition for allowance, and such prompt allowance is earnestly requested.

This Amendment is submitted with a petition for a one month extension of time for reply and the related fee of \$120.00, making this amendment due on or before November 5, 2005. No other fees are believed to be due with this Amendment beyond the \$120.00 fee for a one

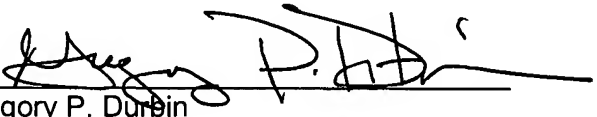
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month extension of time. However, if any additional fees are required, please consider this as authorization therefor and please charge such fees to Deposit Account number 04-1415.

Respectfully submitted,

Date: Nov. 4, 2005

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